The Geopolitics of Climate Knowledge Mobilization:

Transdisciplinary Research at the Science-Policy Interface(s) in the Americas

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Abstract

Climate change and sustainability science have become more international in scope and transdisciplinary in nature, in response to growing expectations that scientific knowledge directly informs collective action and societal transformation. In this article, we move past idealized models of the science-policy interface to examine the social processes and geopolitical dynamics of knowledge mobilization. We argue that sociotechnical imaginaries of transdisciplinary research, deployed in parallel to "universal" regimes of evidence-based decision making from the global North, conceal how international collaborations of scientists and societal actors actually experience knowledge mobilization, its systemic barriers, and its paths to policy action. Through ethnographic study of a transdisciplinary research program in the Americas, coupled

with in-depth analysis of Colombia, we reveal divergences in how participants envision and experience knowledge mobilization, and draw critical attention to persistent disparities that diminish the capacity of researchers to influence decision making and fit climate knowledge within broader neoliberal development paradigms. Results of the study point to a plurality of science-policy interface(s), each shaped by national sociotechnical imaginaries, development priorities, and local social orders. We conclude that a geopolitical approach to transdisciplinary science is necessary to understand how climate and sustainability knowledge circulates unevenly in a world marked by persistent inequality and dominance.

Keywords: epistemic geographies, knowledge coproduction, international science programs, science-policy interface, sociotechnical imaginaries, scale, sustainability science, Colombia

Introduction

Throughout the Americas, science has evolved toward new modes of transdisciplinary knowledge production, aimed at mobilizing climate, health, and sustainability knowledge to inform policy and catalyze societal transformation at multiple scales (de Almeida Filho 2005; Lahsen et al. 2013; Liverman 2009; Max-Neef 2005; Romero-Lankao et al. 2013). Transdisciplinary knowledge regimes reflect implicit logics of accountability and imaginaries of social impact that shape program design, collaboration, and the very conditions for knowledge mobilization and future engagements between science and society (Felt et al. 2016; van der Hel 2016). Such "zones of engagement" are further complicated in developing countries, where Northern technologies and ideals of progress—such as the linear model of the "science-policy interface" in which "value-free" science is adopted and applied by earnest policy advisors

(Jasanoff 2004; Pielke 2007)—are used as benchmarks to facilitate national economic development, scientific infrastructure, and human capacity-building (Lahsen 2009; Lahsen and Nobre 2007; Nunes et al. 2016; Rajão and Duque 2014).

In this article, we advance a "geopolitical" approach to conceptualizing knowledge mobilization in transdisciplinary climate and sustainability research, particularly as the process of moving knowledge into use confronts different spatial and social orders. Climate change geopolitics are not limited to nation states sparring over international treaties, but also include the epistemic geographies of climate and environmental knowledge—such as how space, place, and power are part of the coproduction of knowledge and social order (Mahony and Hulme 2016). Our geopolitical framework elicits the perfomative and place-based aspects of scientific knowledge—or ways of representing the world—which emerge from local social orders and shape conditions of knowledge production and mobilization (Dalby 2013). Feminist approaches to geopolitics, for example, locate broader political struggles over territory, authority, and hegemony in "mundane" and overlooked social practices and sites—in bodies, within collaborations, in everyday spaces and social relations that configure authoritative knowledge (Massaro and Williams 2013). Transdisciplinary science is perhaps the least understood and most contentious regime of climate and environmental knowledge production, as it explicitly incorporates "use-driven" imaginaries of public purpose, development pathways, and desirable futures.

Similarly, in this paper we demonstrate why the sociotechnical imaginaries of transdisciplinary sustainability science must grapple with its lived geopolitical realities at multiple scales. We move past idealized models of the science-policy interface to examine the social processes and geopolitical dynamics of knowledge mobilization. To do this, we first

illustrate how universalized and "global" visions of knowledge mobilization are reproduced in the programmatic design and expectations of "use-driven" research, drawing on a case study of the Fulbright NEXUS, a transdisciplinary research program based in the Americas. Second, we show how NEXUS participants experience and reconcile a plurality of science-policy interface(s), each shaped by national sociotechnical imaginaries, development priorities, and local social orders. We argue that sociotechnical imaginaries of transdisciplinary research, deployed in parallel to global regimes of evidence-based decision making from the global North, conceal how international collaborations of scientists and societal actors actually experience knowledge mobilization, its systemic barriers, and paths to policy action.

Sociotechnical Framings of the Science-Policy Interface

Transdisciplinary research is defined as a mode of knowledge coproduction that involves societal actors in the design, execution, application, and mobilization of knowledge into policy—features that distinguish it from interdisciplinary and multidisciplinary types of scientific collaboration (Groß and Stauffacher 2014; Klenk et al. 2015; Mauser et al. 2013). Transdisciplinary knowledge regimes transform the very practices of science—who is included, how discoveries are made—with the hopeful promise of "democratizing" science-society interactions and legitimizing outcomes and applications (Felt et al. 2016). This model has been upheld as one possible way to "close the gap" between climate knowledge and action (O'Brien 2013).

While there is no single prescription for better integration of science into decision making (Bai et al. 2015), there is equally poor understanding of how transdisciplinary experiments morph into policy and practice, particularly as "use-driven" and "actionable" science becomes intertwined with implicit norms—or "sociotechnical imaginaries"—of public purpose, desirable

futures, and national development (Felt et al. 2016; Jasanoff and Kim 2015). Science-society ideologies, for example, tend to universalize how knowledge translation and application occurs in all places, despite very real place-based differences in development conditions, decision making, and socio-political contexts (Jasanoff and Wynne 1998; Lahsen 2004, 2009). Climate change science is especially prone to this dynamic, given its spatial framing at regional and global scales on the one hand, and its need to compose policy-relevant and locally specific outcomes on the other (Wynne 2010). For programs such as Future Earth, funders promote transdisciplinary models of research as a way to accelerate and improve the "linear" model of knowledge mobilization—where academic experts make discoveries and hand off results to decision-makers (Bai et al. 2015; Leemans 2016).

Transdisciplinary knowledge regimes have a distinct epistemic history based in the global North. Scholars in critical policy studies have tracked the rise of evidence-based policy making (EBPM): the idealized, rationalistic, and nonpolitical perspective that has gained international hegemony among regimes of evidence (Holmes et al. 2016). Government agencies in Europe and North America have implemented EBPM as a response to demands for increased efficiency and transparency in public policy making and to "close the gap" between knowledge production and utilization. Originally, EBPM developed within the health care sector, by using systematic review of clinical trials as the benchmark for "decision-ready" evidence (Hodgkinson 2012). Proponents argue that EBPM demystifies the decision-making process by adopting clear protocols for policy based on the most relevant and rigorous knowledge base—"the best available science"—with the promise of reducing the number of policy failures. Critical policy scholars, meanwhile, question the rationalistic assumptions underlying EBPM. They point to the social construction of evidence, the politics involved in adjudicating the relevance and rigor of

different types of knowledge (e.g. quantitative versus qualitative scientific research, expert judgment, practical knowledge), and the risks associated with the exclusion of certain types of knowledge, such as the interpretive social sciences.

Identifying the "sociotechnical imaginaries" of transdisciplinary science is one way to better understand its tacit ordering rules, epistemic geographies, and potential misalignments. Sheila Jasanoff (2015: 19) and Sang-Hyun Kim define sociotechnical imaginaries as "collectively held and performed visions of desirable futures (or of resistance against the undesirable) that are animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology." Key to the concept is its definition as collective social practice and performance, which ties sociotechnical imaginaries "more closely [to] instrumental political action—in other words, to policy as well as politics" (Jasanoff 2015: 20). The concept was first developed to describe the co-production of science and social order at the site of the nation state, a cradle of policy actions and future-oriented development (Jasanoff and Kim 2009). For example, the goals and practices of a national transdisciplinary research program in Austria were mutually constitutive with national identity ("being Austrian"), local visions of "sustainability," and place-based visions of who should be included in the research (Felt et al. 2016).

While national programs are important sites for investigation, this paper seeks to expand analysis of geopolitical dynamics at multiple sites and scales. Such critical work is already underway in STS. For example, Myanna Lahsen (2002, 2009) explains how rifts between scientists and policy makers, in debates over global carbon cycle research in Brazil, are rooted in localized notions of national sovereignty, territorial hegemony, and political control. Brazilian decision makers, she found, portrayed "international science" as a mechanism through which

rich countries maintained geopolitical advantage and influence over Amazonian territory and resources (Lahsen 2002: 4). Resulting policy interpretations diverged sharply from the scientific consensus, which considered the Amazon a key site in "global" environmental dynamics (Lahsen 2009). Participating Brazilian scientists, meanwhile, reported a "North American bias" in program design and execution, and described feelings of being used as a "token scientist" rather than an equal participant (Lahsen 2002, 2009). As one participant explained, "this issue of what I call colonialism in science, it exists. It is *very* strong. And nobody talks about it. On either side. Who profits and who suffers." (Lahsen 2002: 19-20).

Transdisciplinary research is caught within a dominant regime of evidence, idealized as a model of "input-output," "delivery-uptake," and "supply-demand" which assumes a nonpolitical science-policy interface, on the one hand, and on the other obscures how such a sociotechnical imaginary can displace alternative pathways of knowledge mobilization. Our paper examines the ways that transdisciplinary knowledge mobilizes and co-produces the science-policy interface in different geographic contexts that span the development gradient of the Americas. We anticipate that a geopolitical exploration will reveal a plurality of science-policy interface(s), including the power imbalances between knowledge systems attempting to steer global environmental change science and decision making. To explore these dynamics, we delve into the NEXUS case.

The Fulbright NEXUS

Perspectives and experiences from the Americas are profoundly instructive for advancing critical STS theories of international science and interdisciplinary collaboration (Anderson 2002; Harding 2016; Rajão et al. 2014; Vessuri 1987). Key programmatic precedents in the region, such as the Inter-American Institute for Global Change Research (IAI), have established a two-

decade legacy of South-North collaboration and interdisciplinary, policy-driven research in climate change and sustainability sciences (Liverman 2009).

Fulbright NEXUS is a transdisciplinary research program, jointly sponsored by the US State Department and Brazilian Ministry of Education, designed to address climate change, energy, and health challenges in the Western Hemisphere. The NEXUS case is notable for two reasons. First, its geographic diversity invites a plurality of science-policy imaginaries, transdisciplinary configurations, and "performances" in knowledge mobilization. To date, most critical studies of transdisciplinary science have focused on national programs based in North America and Western Europe (Felt et al. 2016; Groß and Stauffacher 2014; Mattor et al. 2014; Turnhout et al. 2008) or the "global" approach taken by Future Earth (Lahsen 2016, van der Hel 2016). NEXUS assembled researchers and societal actors from all corners of the Americas, including its wealthiest and poorest countries. Through its regional focus and stakeholder-driven design, the program is an ideal template to elicit diverse imaginaries and social practices that are central to theorize knowledge mobilization.

Second, NEXUS was also designed as a "cultural exchange," unlike most transdisciplinary programs that focus strictly on science-generating activities. As NEXUS scholars ourselves, we experienced this cultural exchange first-hand: during six-week visits to the country where our research was conducted, by engaging with project stakeholders with different capacities of decision making, and through reflection on such experiences with other scholars during week-long NEXUS meetings. The program served as an experimental container, assembling scholars and stakeholders and tasking them to conduct policy-relevant research, all while facilitating diverse opportunities for research teams to immerse themselves in different cultures and to confront different sociotechnical imaginaries. Such encounters inevitably shaped the trajectory of

our argument. In bringing together people from across the Americas, the NEXUS program sought to cultivate *hybrid* researchers—socially-engaged policy informants.

Methods and Materials

We adopted an ethnographic and interpretive approach to data collection and analysis. As NEXUS scholars, we were immersed in our case study, which enabled participant observation, reflective engagement, and grounded insight into the program's implementation. The article draws on our experiences and two other bodies of materials: (1) semi-structured interviews with NEXUS scholars and program staff, and (2) program concept papers and project outputs such as diagrams, websites, presentations, articles, and notes.

We invited 63 participants from three NEXUS cohorts implemented by the Fulbright program (in 2011, 2012, and 2014) and interviewed 30 scholars (48% response rate) and six program staff (86% response rate) for a total of 36 interviews. Participants have advanced degrees in science, engineering, design, architecture, public health, social science, and the humanities. Most NEXUS scholars work as university academics, though several have current (or previous) positions in government agencies, international research institutes, civil society organizations, and private firms. Women represent 43% of total NEXUS scholars, a proportion mirrored by our recruited interview participants (43% women, 57% men). Among the 30 interviewed scholars, 12 are based in Canada and the United States, with the remaining 18 located in Latin America and the Caribbean.

We were mindful that our position as NEXUS "insiders" might present challenges in the study: would interviewees interpret the study as directed by program staff? Would interviewees be reticent to speak openly about the nature of their collaborations? The first two authors of this

article conducted the interviews and did not experience any awkward conversations. To the contrary, NEXUS participants were eager to tell their stories. At the same time, we cannot account for the sentiments of those who chose not to participate. While the views presented here are not exhaustively representative of the program, we do not seek such quantifiable data. Our objective is to elicit an ethnographic explanation of transdisciplinary research and knowledge mobilization, from the perspective of science as human practice embedded in particular social orders.

In analysis, we coded and interpreted data to elicit the key imaginaries, discourses, and practices in knowledge integration and mobilization, relying on a mix of grounded theory and extensive review of transdisciplinary science (Klenk and Meehan 2015). To protect informant confidentiality while conveying important details about participants, we balance the use of participant pseudonyms (presented as numbers in brackets) with details that disclose location, nationality, and gender.

Transdisciplinary Knowledge Politics

In this section, we examine transdisciplinary knowledge mobilization at three important sites of coproduction: at the scales of global circulation, the nation state, and individual participants. Following Escobar (2008), we understand scale not as a vertical hierarchy of nested models, but as immanent, emergent, and embodied "sites" of spatial and social relations. NEXUS participants experienced geopolitical dynamics at all three "scales" to varying degrees. We first examine how universalized and "global" visions of knowledge mobilization are reproduced in the programmatic design and expectations of NEXUS, even though participants encountered a

plurality of the science-policy interface(s) and systemic barriers that shaped pathways for knowledge mobilization.

Second, we explore the "national" sociotechnical imaginaries of transdisciplinarity as mechanisms of national economic development, exemplified by the case of Colombia, which selectively limits what kinds of knowledge can even be mobilized across the science-policy interface. NEXUS participants working in Colombia find themselves, on the one hand, riding the crest of a popular scientific paradigm; and on the other, caught in sieve that favors—in their words—knowledge that creates more market-ready "D" (development) than basic "R" (research).

Finally, we explore the geopolitics of knowledge mobilization at the site of the individual. As Fulbright grant recipients, NEXUS scientists and stakeholders were expected to stand in as national subjects—literally, as cultural ambassadors of their country—and to partake in knowledge and cultural exchange activities throughout the hemisphere. Participants had to confront and negotiate broader systems of cultural and socioeconomic difference within teams, which was elevated by even starker differences between the capacities of decision makers and scientists. Friction was inescapable; but as we point to in the concluding section, the NEXUS program also tested new pathways of productive collaboration and action.

Global Regimes of Knowledge Mobilization

Transdisciplinary and international models of scientific collaboration, informed by a logic and desire for evidence-based policy, served as the blueprint for the funding, organization, and desired impact of the Fulbright NEXUS program. NEXUS was initially created in 2010 during a meeting of staff from the US State Department (Bureau of Educational and Cultural Affairs,

ECA) and Fulbright Commission directors from Latin America. Staff met to craft a "new model for Fulbright research" based on collaborative, problem-oriented, regional research—"the idea came to life in that meeting." Unlike other Fulbright programs, the NEXUS emphasized team-based transdisciplinary research. The first cohort (2011-12) featured scholars doing mostly independent research with their own selected stakeholders. The second cohort (2012-13) continued to fund individual projects, and also implemented requirements for small group research with other NEXUS scholars and stakeholders. By the third cohort (2014-16), Fulbright staff increased grant length to two years and jettisoned independent projects in favor of only team-based research with stakeholders.

Climate change policies quickly became one of the central planks of the program, "especially as President Obama started to talk a lot more about climate change in public." While countries in Latin America, such as Mexico, were already leaders in developing national climate policies, the climate-friendly rhetoric of the Obama administration was key to unlocking programmatic possibilities for the NEXUS. "When we opened the first cohort competition," recalls a staff member, "we had a large share of people who proposed programs related to climate change." Topics emerged organically and included diverse aspects of climate change, including projects about climate science (modeling and prediction), mitigation (low-carbon energy development), adaptation (farmer responses to market shocks and extreme weather events), and societal transformation (hazard communication). By the second cohort, "a decision was made to move to climate change more fully because people in my office were working on it and thought it was important. We've been given new guidance from above."

From the start, the regional focus of NEXUS (the "Western Hemisphere") reflects the spatial vision of the US State Department—"you know, the world regions that we're structured around

here at State" —and how the Department structures its internal offices and bureaus, including the units that house the NEXUS program. It is important to note that the "Western Hemisphere" is a constructed spatial imaginary and social order. Regional bureaus were initially developed in the 1870s and mirrored colonial divisions of the world, early struggles of nation formation, and intense economic competition. In 1910, the State Department formally established the Western Hemisphere bureau, a portfolio of 39 countries (including Canada, Latin America, and the Caribbean), with the goal of sustaining regional hegemonic power within a globalizing world order (Moore 2016). This geospatial order was not lost on NEXUS participants. Most participants identified NEXUS as an "American" (read: USA) program, despite its hemispheric template and co-funding with Brazil. For the Chilean participant below, NEXUS represents the norms, standards, and expectations of US scientific institutions, a point she makes by using the interviewer as a prime example:

> Participant 28: Where are you from, Katie?
>
> Interviewer (Katie): I'm from the United States.
>
> P28: Yeah, therefore you are different because you have the background of the people from Fulbright, you know what I mean. But we are from South America and things are quite different here.

Programmatic antecedents such as the Fulbright New Century Scholars program (2001-2010) were "global" in mandate and scope, yet NEXUS adopted a regional model. Staff hoped that a shared region would facilitate collaboration and improve outcomes of knowledge mobilization:

> I think the general idea was like, if you bring a group of people together from the same region that are working towards the same goal and on the same issues, [then] we have an effective program model.

Funding also reflected regional power dynamics. The Brazilian Ministry of Education, at the "apex of their glory" in terms of science funding in 2014, partnered with the State Department to jointly sponsor the third NEXUS cohort. "It didn't hurt that at the time Brazil was involved with strategic partnership dialogues," explains a staff member, "and at the Summit of the Americas, there [was] renewed focus on US relations with its Latin American and Canadian neighbors." Consequently, the third cohort featured a more prominent number of Brazilian scholars, direct involvement by the Brazilian Fulbright Commission in meetings, and guest appearances by prominent Brazilian global change scientists, diplomats, and ministry representatives.

From the very beginning, NEXUS was designed to "reach across" the science-policy interface—to foster "that culture of young researchers trying to inform [policy] with their work" that, according to program staff, is less valued in university settings and academic culture. The NEXUS vision was underpinned by a strong belief, held by staff and participants alike, that stakeholder involvement resulted in improved knowledge mobilization and policy outcomes:

> The idea was fantastic, I think, linking knowledge in general but linking scientific research with the process of elaborating policy, [that's] wonderful. It's a very basic premise: you believe that policy will be better if it is informed by science and technology. That is what NEXUS was trying to do, is [to] connect policy with science research.

Scholars shared a similar view that research should "leave the lab" and interact with society:

> Let's get a little bit philosophical. NEXUS is what we should have been doing for a long time. People in universities throughout the world, we tend to focus a lot on what the professors around us tell us what should be done. You don't get many chances to see a guy who arrives late at a meeting because he had trouble with a camel in South Sudan. You need

> to look outside the fences around your university. Research has to impact someone and it can't be done just by staying in the lab.

At the beginning of each cohort, NEXUS participants were trained—or, as one participant jokingly described, "brainwashed"—on the benefits of mobilizing knowledge into practice.

> We spent so much time both at the initial meeting and I think also the Mexico meeting talking about how scientific research could be translated to policy. Like, how to have an impact. That science should have an impact on people—not only science for science, science for knowledge. But science to create benefit for people.

While NEXUS included scholars from Canada and the United States, its target audience was, in practice, policy makers in the "developing countries" of the Western Hemisphere. With few exceptions, nearly all of the individual and group research projects took place in Latin America and the Caribbean. No groups worked collectively on climate change knowledge mobilization in Canada or the United States—a great irony, given these countries' role as major generators of greenhouse gases, and the urgent need for science-policy transformation regarding climate change in the United States. While NEXUS advanced the model of transdisciplinary sustainability research beyond efforts at "national" or "global" levels, it also reproduced the dominant patterns that characterize international scientific collaborations, where scientific theory and funding dollars radiate from the North to be "applied" in the environmental and social contexts of the South (Lahsen 2002; Nobre et al. 2008; Vessuri 1986, 1990).

In sum, the NEXUS program promoted a distinct sociotechnical imaginary of knowledge mobilization—one in which the region was the desirable geographic unit of scientific partnership; the inclusion of extra-scientific actors would yield improved policy outcomes; and problems of climate change, health, and environmental sustainability naturally lent themselves to

transdisciplinary inquiry and application. In what follows, we document how the experiences of participants diverged from the transdisciplinary ideal; participants encountered a plurality of science-policy interfaces, including entrenched national priorities and political economic imperatives.

Neoliberal Development and Knowledge Mobilization in Colombia

Scientific discovery and knowledge production have a long geopolitical history in the Americas, through their use as instruments of colonial territorial expansion, sovereignty claims, and resource control and development (Hecht 2013; Lahsen 2002; Vessuri 1986, 1987). Against the backdrop of regional trends of scientific isolation and state disinvestment in research during the 1980s (Vessuri 1990), in the past two decades Colombia has increasingly promoted and institutionalized transdisciplinary science. The Colombian government justifies investments in transdisciplinary initiatives, scientific infrastructure, and human and institutional capacity as a means to foster economic growth and international competitiveness, ensure efficient and sustainable use of natural resources, and resolve social problems of violence, poverty, and inequality (Bortagaray and Gras 2014: 273; Crespi and Dutrénit 2014). Not surprisingly, this mandate is a tall order for a country newly emerging from a six-decade, tumultuous civil war.

Colciencias (the Administrative Department of Science, Technology and Innovation) was established in 1968 as the financial fund and national coordinating body for scientific and technological development in Colombia. Since the 1980s, the agency has incrementally reformed its policies and institutional structure to incentivize and reward transdisciplinary-style knowledge mobilization. Milestones include the development of the National Innovation System (in 1995), the adoption of international standards for research (in 2000), the development of national STI

plans (in 1998, 2006, and 2010), and the passage of Law 1286 (in 2009) that elevated Colciencias to the equivalent of a ministry and stabilized its budgetary independence (Bortagaray and Gras 2014). By the year 2000, Colciencias had developed clear policies and funding mechanisms to reward science for the productive sector (Bortagaray and Gras 2014; Pérez-Rincón 2014).

NEXUS participants working in Colombia inevitably encountered its national imaginary of "useful" science. Reflecting on the shift, a Colombian NEXUS participant explained the trade-offs involved when societal actors—namely, elected representatives in the government—are in positions to shape the expectations and conditions of knowledge mobilization:

> Politicians really want results. They just don't want academic, blue sky research, they want something applied so that they can show to others and keep them happy, so they can be elected for the following year. Most of the research that is being done in Colombia is somewhat applied research. The problem with this is the blue sky fundamental research is not receiving much funding now.

With politicians at the helm, the participant continued, science risks losing its "objective" status, as academics become mere "consultants" for market innovation and political will. "Applied research poses the risk of becoming a consultancy," he said, "just something a company can do—something being shown as research but it's just developing. Not much R but mostly D. Especially due to the politics involved."

Knowledge mobilization for big "D" development is certainly on the Colombian scientific agenda, especially without the presence of the guerrillas and organized opposition. With the formal launch of Colombia's accession process to the OECD and the signature and ratification of the peace agreement, there exists new institutional pressure to develop natural resources—

mining, oil, and industrial agriculture—that are evident in "sustainable development" instruments like the Green Economy Mission, launched in 2015 by the Colombian National Department of Planning (DNP). "Colombia has promoted the neo-extractivist path [to development]," writes Mario Pérez-Rincón (2015: 82), "through the design and implementation of a series of policies crafted by decision-makers and an international context that promotes it." The road map to the green economy includes STI activities and policies that call for more efficient use of natural resources and improved economic development, but fail to recognize the roots of ongoing land use and water conflicts across the country and the extractivist mode of environmental governance (Perez-Rincón 2014).

With the passage of *Scientific Colombia*, the latest national STI policy plan (for 2015-2025), the Colombian government institutionalized a vision of transdisciplinary science that fosters international networks, innovation in the productive sector, and market-ready technologies. Specifically, the plan gives funding to Colombian universities that partner with at least one private sector firm and one of the top 500 world universities, as rated by the Academic Ranking of World Universities. The stated purpose of this reform is to increase global competitiveness and productivity that contribute to development of the country. Large amounts of money are promised to research initiatives that include nanotechnology or biotechnology, as well as proposals that include patents, products, and efforts to strengthen the productive sector.

New STI policies in Colombia are, in part, justified as a means to improve human rights, social development, and the sustainable use of natural resources (Bortagaray and Gras 2014). Despite such promise, in practice transdisciplinary knowledge mobilization has to navigate real structural barriers in Colombia: regional poverty and power asymmetries, the historical legacy of violence and conflict, and "market-ready" imperatives to compete internationally. High oil prices

allowed investment in regional scientific infrastructure for many years, but the process began to resemble institutions characterized by productive sector outcomes, rather than by goals to advance basic knowledge (see also Vessuri 1990). Funding is flush, this NEXUS participant explained, but the close involvement of government implies trade-offs:

> Participant 6: The Colombian government decided to dedicate 10% of royalties from oil and coal and mining to R&D. And this money was given to the departments, which are like states in Colombia. They [the states] would define the areas of interest they want to invest in. This had an interesting outcome, a negative one. The problem was that too much politics was involved. Projects doesn't get [approved] if the Colombian government doesn't want, if the government doesn't like it. Even though before it [a project] gets accepted, it needs to get accepted by Colciencias, like a similar [approval] process. Even though in some departments, it definitely went to corruption, unfortunately. So for example: a million dollar project for a document—a 30 page document.
>
> Interviewer: Wow.
>
> P6: Yeah, exactly.

Crucially, this story reveals more about transdisciplinary knowledge regimes than just "corruption" and poor management. Colombia's shift toward transdisciplinarity introduces a deliberate "politicization" of science that disrupts closely held scientific norms of objectivity and value-free knowledge, as the NEXUS participant notes. Given the Colombian government's aim to develop competitively on the global stage, knowledge regimes are at the mercy of government economic priorities, which are clearly neo-extractivist in character (Pérez-Rincón 2014), and

reflect a trend toward the commercialization of academic outputs and knowledge production (Vessuri and Bueno 2016).

We use these stories to illustrate that national sociotechnical imaginaries selectively limit what types of knowledge can even be mobilized across the science-policy interface. Geopolitical dynamics matter here. In the case of Colombia, the neo-extractivist model of development selects for profit-yielding and export-oriented transdisciplinary projects—a depressing reality for climate change, health, and sustainability researchers studying, say, vulnerability and adaptation. Yet, as our informants suggest, national imaginaries, science-society relations, and the conditions for knowledge mobilization shift across place. A personal NEXUS anecdote, set in the United States, provides a brief illustration. In May 2016 we traveled to Washington, D.C. and presented research briefs to policy organizations and decision makers. During a conversation with a member of the US House of Representatives who serves on the House Committee for Science and Technology Policy, we asked what types of climate change research or information are most useful in her job. She responded that S&TP committee members, under leadership of climate skeptics, are prevented from using the phrases "climate change" and "global warming" in internal meetings, documents, or legislation. In the United States, climate-related research cannot even get through the front door of legislative bodies.

These examples are "geopolitical" in the sense that they reveal a plurality of science-policy interfaces produced by local social orders and global hegemonic ideas and practices. Such testimonies also expose the real-life constraints of decision makers, who operate in worlds that refute any "rationalist" and depoliticized characterizations. For scientists attempting to meaningfully link climate knowledge with policy action and societal transformation—the core thrust of NEXUS and cognate programs like Future Earth—such conditions shape the very

pathways of knowledge mobilization, including which types of knowledge are even deemed acceptable, valuable, or translatable into policy, and how such experiments will succeed in "developed" countries like the United States, where knowledge mobilization is just as (geo)political as everywhere else.

Embodied Geopolitics of Knowledge Mobilization

NEXUS participants routinely confronted and struggled with the geopolitical dynamics of knowledge mobilization in embodied ways, reconciling global and national discourses with experiences at the scale of individuals. Language provides an illustrative example. Participants described deferring to scholars with English fluency, frustrated by the dual challenges of merging academic and national languages. Knowledge production in English served to expedite its dissemination for a "global" audience of academics, yet undermined its potential for use in the language of the stakeholders—whom this research intended to transform. Not all participants felt comfortable with this practice, even if they complied. Feelings of anxiety and guilt, expressed by this US participant, accompanied the hegemony of Anglo-American academic norms and standards that are imported through language:

> I must admit, in international collaborations, something that I always feel a little, I don't know, a little reluctant is that the other person who ended up leading a lot was another American. I always feel like this part of it is the language issue, being able to write easily in English. It's always an advantage in these kinds of things, knowing the formula writing of articles. It would have been nice to have more leadership from the region [Latin America and the Caribbean] but that's the way it came out.

Not only did using the English language provide a license to import knowledge traditions, epistemic beliefs, and norms of research practice—marginalizing scholarship in local languages—it also served to reproduce socioeconomic and class divisions.

For example, many of the Latin American participants spoke fluent English, were trained abroad (in US, Canadian, or European universities), and held extensive networks and collaborators in the United States. Class divisions, coupled with nationalist stereotypes, influenced how research problems and cases were imagined, selected, and understood, as this US participant explains:

> The other thing is there are cultural differences. Like, we ended up doing our project on Nicaragua. And a lot of the people from Latin America in the group were from Argentina, Chile, Colombia. And they were from the upper classes and they had no interest in Nicaragua, none whatsoever. Especially because it is a very leftist country, and they felt like we had an agenda as American academics. I don't think that people in the group really spoke up about their preferences or what they wanted to do, they were just kind of like "we have to do it because it's not our first choice, we're going to do the bare minimum sort of thing" . . . No one really spoke up, I think because they just felt like [the leaders] had everything under control and maybe the tendency to defer to Americans because it was an American program, and of course there's all these power dynamics.

Unlike most transdisciplinary programs, where national or class differences are muted or subsumed, NEXUS scientists and stakeholders were expected to stand in as national subjects—literally, as cultural ambassadors of their country—and to partake in cultural exchange activities throughout the hemisphere, culminating in a final "policy impact" meeting in Washington, D.C. Participating scientists, no matter how open to international collaboration, had to negotiate

broader systems of cultural and socioeconomic difference that shape individual capacities to actually mobilize knowledge into policy, especially with local stakeholders thrown in the mix.

NEXUS participants used several metaphors to describe knowledge mobilization. While some invoked positive and idealized associations ("fantastic"; "wonderful"; the "sweet spot"), others utilized metaphors that described the science-policy interface in terms of a chasm, a "middle point," or a "wall." Mobilizing knowledge required navigating differences in work standards, cultural expectations, institutional mandates, and reward structures that created very different operating conditions for scientists versus stakeholders.

> Sometimes [policy makers] need to make the decision really fast and they can't wait to run the whole model, like weeks or even months. They need to make a decision right now! It's really hard because you want to be as rigorous as possible, but sometimes maybe having some information can help the decision making, it doesn't have to be perfect. You need to decide where to stop.

Perhaps the biggest rift emerged when NEXUS scholars worked with politicians or political appointees in government—a necessity for investigators who needed research permission, access to sensitive or large-scale data, or who desired proximity to individuals who are "close to power." "If you're not really next to the politicians that is very difficult no matter how good project you do," a participant explained, "From my experience as a Chilean, if you don't have somebody supporting you there from a good level that could influence decision making and policy, that's difficult." Yet, as this Argentine explains, political appointees come and go, thus requiring scientists to locate more "permanent" but perhaps less influential public employees:

Participant 7: There are [knowledgeable] people but they are lost in the structure. It's not like a developed country, you know. It's very different because perhaps in your countries only the head changes, but here no.

Interviewer: Did you notice differences with colleagues from different countries?

P7: No, that was another interesting issue. We all had the same problem. Our group had people from Argentina, in my case and another colleague from Argentina but isn't working with the public sector, and there was the guy from Uruguay and another person from Colombia. And we all had the same issues with stakeholders. I think that it is still true that in developing countries the interface between academia and the public sector is more difficult.

Metaphors of conduits, champions, and direct lines of entry into policy making refer to an idealized model of the science-policy interface, in which researchers expect to produce useable knowledge only if they are connected to the "right" level of decision making. As the NEXUS stories explain, to achieve the transdisciplinary mandate—to establish a close working relationship with "influential" policy actors—participants must navigate differing organizational, institutional, political-economic, and knowledge seeking practices, especially between scientists and stakeholders.

A geopolitical approach to knowledge mobilization implies that the path linking research with policy is neither linear nor singular; scientists must navigate highly localized landscapes of development priorities, institutional capacity, territorial claims, socioeconomic differences, and power asymmetries at multiple scales. In the case of NEXUS, science-policy interface(s) are fundamentally plural. While stakeholders are assumed to be vectors of knowledge and catalyzers of action, in practice they may resist "evidence-based" decision making if such knowledge does

not fit organizational priorities, political economic imperatives, or if they are positioned at the "wrong" level of government to effect change.

The extent to which programs like NEXUS open up alternative paths to dealing with the future of climate and development depends, in part, on how research is imagined and designed to inform decision making at different scales, and whether societal actors are empowered to shape research in a way that may challenge global framings of climate issues, governance, and solutions. Local decision-makers may not be attractive to researchers, if they lack power to suitably effect change; conversely, without their input, it seems unlikely that research will contribute to the crafting of locally appropriate climate responses. The NEXUS case reveals how sociotechnical imaginaries reflect variegated constructions of space and social order—a fact that current models of transdisciplinary sustainability science, in their ambition to produce universal knowledge, fail to reckon with.

Conclusion

Transdisciplinary research holds great promise for igniting climate and sustainability knowledge into policy action. In this paper, we moved past idealized models of knowledge mobilization—the "linear" model that relies on the "best evidence" available—to draw attention to the geopolitics of the mobilization process: its plural imaginaries and misalignments of how science should impact policy, national development agendas that differentially shape capacities to mobilize knowledge, and resistance to imposed rationalistic models of a singular science-policy interface. Through the case of the Fulbright NEXUS program, we sought to advance a geopolitical understanding of the epistemic geographies of transdisciplinary science, which is necessary to characterize how scientific knowledge circulates in "a world of persistent inequality

and dominance" (Jasanoff 2015: 22). With the growth of transdisciplinary science as a mechanism of market-ready development, as in Colombia, there is even greater need for critical understanding of how scientific knowledge regimes operate in practice to empower marginalized communities and developing countries (Nobre et al. 2008). Our study provides a useful starting point.

Reflecting on our own experiences of the NEXUS collaboration, we briefly conclude with two potential lessons for similar transdisciplinary efforts. First, climate and sustainability science should learn from the "Latin American School" of social medicine and public health, with its longstanding history of transdisciplinary design, applied practice, and direct action for human welfare and social justice, often in contexts of extreme socioeconomic and environmental inequality (Méndez 2015). In Colombia, the field of public health has yielded successful examples of knowledge coproduction, scientific innovations, and policy applications. For example, scientists and practitioners have identified and synthesized the determinants of health from different schools of thought, a process that requires the coordination of multiple organizations, disciplines, policy tools, and ethical considerations that go beyond the identification of biophysical risk factors (Méndez 2015). Researchers in Latin American social medicine conceptualize the health-disease-action process with an emphasis on translating results into a coherent and just social response (see Iriart 2002)—supporting what Boaventura de Sousa Santos (2007) calls "epistemologies of the South" by lending visibility and credibility to the cognitive practices of those who have been historically exploited and oppressed by extractive colonialism and global capitalism.

Second, we have found that rather than seek to locate the "right" stakeholder or "perfect" team, knowledge production and mobilization should be viewed as intimately entangled,

dynamic, and political practices. Engaging with a local decision maker has also meant negotiating a web of decision makers at higher levels and differing capacities, as well as with national sociotechnical imaginaries—including desired futures, public policies, and international political economies. Rather than connect the right dots, our experiences suggest a process of negotiation, entanglement, and testing potential paths of action (Callon et al. 2011). Moving along these paths is the task at hand for transdisciplinarity. There is no silver bullet; transdisciplinary climate and sustainability research must grapple with its epistemic geographies and lived geopolitical realities to truly change the intellectual climate.

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